AMENDMENTS TO THE DRAWINGS

The attached sheet of drawings includes changes to FIG. 1. This sheet replaces the original sheets including FIG. 1.

ATTACHMENTS: REPLACEMENT SHEETS

A replacement sheet for FIG. 1 is attached.

REMARKS/ARGUMENTS

The amendments and remarks hereto attend to all outstanding issues in the pending office action of 21 March, 2008. Claims 1-23 are pending in this application before the amendments herein. Claims 1, 8, 9, 12, 14 and 16-22 are amended. Claims 24-37 are new.

In the Drawings

FIG. 1 is amended to replace the phrase "linearization process 110" with "linearization processor 110" and "post process 108" with "post processor 108." This change corrects typographical errors in FIG. 1 as filed. Support for the term "linearization processor" is found at least at paragraph [0008] and in claim 1 as filed; support for the term "post processor" is found at least at paragraphs [0018], [0021] and [0029], and in claims 8 and 9 as filed. No new matter is added to the application by the amendment of FIG. 1.

In the Specification

Applicant has amended the specification to replace all occurrences of the phrase "linearization process" with "linearization processor". This change corrects typographical errors in the specification as filed. Support for this term is found at least at paragraph [0008] and claim 1 as filed. No new matter is added to the application by any of the specification amendments.

In the Claims

Claim 1 is amended to clarify that the linearization processor is utilized to linearize the intermediate image detected by the non-linear detector. This amendment is supported, for example, in FIG. 1 and at paragraph [0020] (emphasis added):

> [0020] A linearization process 110 linearizes data from detector 106. By way of example, if non-linear detector 106 is photographic film, linearization process 110 may include a digital scanner than scans the photographic image of intermediate image 103. In another example, if non-linear detector 106 is a non-linear digital detector (e.g., a CMOS array with a non-linear circuit, or detector elements with individual, non-linear responses), then linearization process 110 may include digital processing to linearize digital data from detector 106. In one embodiment, data from detector 106 is linearized by linearization process 110 to form linearized image 112 by utilizing a priori knowledge of the exposure curve of detector 106 (for example the gamma

> curve of photographic film as detector 106), and/or by measuring the exposure curve.

Claim 8 is amended to clarify that the post-processor is utilized to remove effects of wavefront coding from the linearized image to form a final image. This amendment is supported, for example, in FIG. 1 and at paragraph [0021] (emphasis added):

> [0021] In one embodiment, linearized image 112 is a linear representation of intermediate image 103 which would have been captured by a linear detector in place of non-linear detector 106.. In the embodiment, post-processor 108 then processes or filters linearized image 112 by removing wavefront coding effects of mask 102 to form a final image 114 with increased depth of field and/or reduced focus-related aberration(s). Final image 114 is a sharp (e.g., in-focus) image as compared to intermediate image 103.

Claim 9 is amended to correctly identify the linearization processor as the component of the imaging system that linearizes the intermediate image. Support for this amendment is found in paragraph [0020], as quoted above.

Claim 12 is amended to remove the word "a" to correct a grammatical error.

Claim 14 is amended to add a period.

Claims 16-22 are amended to depend from claim 15 instead of from claim 13, to correct an obvious typgraphical error at the time of filing (claims 16-22 are dependent method claims and cannot properly depend from apparatus claim 13).

New claims 24-37 are believed patentable because they derive from claims indicated by the Examiner as allowable, as discussed below under "Allowable Subject Matter."

No new matter is added to the application through any of the claim amendments.

Response to Office Action

The following sections follow the order of the sections in the Office Action mailed 21 March, 2008 in this application.

1 - 3. Claim Rejections - 35 U.S.C. §112

Claim 8 stands rejected under 35 U.S.C. §112 as being indefinite. The Office Action states, in paragraphs 2-3:

> Claim 8 is rejected under 35 U.S.C 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.
>
> It is unclear whether the post processor recited in Claim 7 [sic] is integrated with the linearization processor in parent Claim 1 or is a separate component, as the post processor linearizes the immediate image to form a linearized image (as recited in Claim 7 [sic]), but the processor in parent Claim 1 is recited as a linearization processor. Therefore, it is unclear which component performs the linearization or whether the two processors are actually a single processor.

While the Examiner refers to claim 7 in the paragraph 3 arguments, Applicants assume that the Examiner is referring to claim 8, as stated in paragraph 2 of the Office Action. Applicants note that both claim 1 and claim 8 have been amended to clarify that the linearization processor linearizes the intermediate image to form a linearized image, and that the post-processor is utilized to remove the effects of wavefront coding from the linearized image to form a final image. Applicants believe that these amendments are sufficient to overcome the rejection under 35 U.S.C. §112. Reconsideration and withdrawal of the rejection of claim 8 under 35 U.S.C. §112, second paragraph is requested.

4 - 5 Claim Rejections – 35 USC §102(b)

Claims 1-3, 8, 11, and 15 stand rejected under 35 USC §102(b) as anticipated by U.S. Patent No. 6,097,856 ("Hammond" herein).

Claim 1

Claim 1, as currently amended, requires:

optics for focusing and encoding a wavefront from the object to an intermediate image such that an optical transfer function of the optical system, at the intermediate image, is more invariant to focus-related aberrations as compared to an intermediate image formed by the optics without encoding;

a non-linear detector for detecting the intermediate image; and

a linearization processor for linearizing the intermediate image to form a linearized image.

The Office Action states, in paragraph 5:

> "Regarding Claim 1, Hammond teaches (see Fig. 2) a non-linear optical system for imaging an object (10) comprising: optics(22,24) for focusing and encoding a wavefront from the object to an intermediate image such that an optical transfer function of the optical system, at the intermediate image, is more invariant to focus-related aberrations as compared to an intermediate image formed by the optics without encoding (see Col. 7, lines 25-35); a non-linear detector (30) (see Col. 8, lines 63-67) for detecting the intermediate image; and a linearization processor (40) for electronically capturing the intermediate image (see Col. 7, lines 23-30)." Office Action, page 3.

Applicants respectfully point out that the Office Action mis-characterizes the optical system described by Hammond as a "non-linear optical system". In particular, where the Examiner states that Hammond teaches "a non-linear detector (30) (see Col, 8, lines 63-67) for detecting the intermediate image" this passage in Hammond in fact describes a linear detector. The passage from Hammond reads as follows:

> "Each of these elements has an amplitude which is proportional to the time averaged result of the superposition of the squares of the absolute values of the coherent PSFs of all points of the object that are projected onto the respective photo sensitive elements." Hammond, col. 8, lines 63-67

The Office Action's interpretation of this passage as describing a non-linear detector is incorrect. In fact, the term "...the squares of the absolute values of the coherent PSFs" is known in the art as equivalent to the term "the incoherent PSFs," or simply "the intensity." Given this well-known definition, the description of the detector in this passage could be written equivalently as: "Each of these elements has an amplitude which is proportional to the time averaged result of the superposition <u>of the intensities</u> of all points of the object that are projected on to the respective photo sensitive elements." In other words, the sensor described exhibits a response that is linearly proportional to intensity – it is a <u>linear detector.</u> Hammond does <u>not</u>, therefore, teach using a "non-linear detector for detecting the intermediate image", as required by Claim 1.

Furthermore, the Office Action characterizes Hammond's signal processor (40) as a linearization processor for electronically capturing an intermediate image. Applicants first note that as amended, claim 1 requires a linearization processor to linearize the intermediate image and form a linear image. Hammond's signal processor does not "linearize" anything

- and does not have to, because Hammond does not disclose a non-linear detector. The specific passage quoted from Hammond reads:

> "...it is the function of DSP 40-1 to recover a representation of the original object which has been compensated for misfocus and for as many of the errors introduced by the associated optical assembly as is practicable. This operation is referred to herein as the "recovery process: or :recovery algorithm" and makes use of the generalized recovery function of the invention." Hammond, col. 9, lines 1-7.

The quoted section of Hammond therefore does not disclose the DSP as linearizing an image (whether captured by a non-linear detector or not), but instead, recovers the image by removing the effects of a phase mask. Details regarding DSP 40-1 and the recovery function are found, for example, at col. 13, lines 35-56 of Hammond. This section re-emphasizes that the recovery function is used to remove effects caused by a phase mask and other aberrations inherent in the optical system. It is not used for "linearizing the intermediate image to form a linearized image" as required by claim 1.

Clearly, Hammond discloses neither a non-linear detector nor a linearization processor. For at least these reasons, Applicants believe that Hammond does not anticipate claim 1 under 35 U.S.C. §102(b); reconsideration and withdrawal of the rejection of claim 1 is requested.

Claims 2, 3, 8, and 11

Claims 2, 3, 8, and 11 also stand rejected under 35 U.S.C. §102(b) as anticipated by Hammond. Applicants note that each of these claims depends directly or indirectly from claim 1 and benefits from like arguments. Furthermore, these claims have additional features that render them patentably distinguished over Hammond. For example, claim 11 recites a non-linear digital detector, which Hammond does not teach, as argued above in connection with claim 1. For at least the reasons set forth above, Hammond does not anticipate claims 2, 3, 8, and 11 under 35 U.S.C. §102(b); reconsideration and withdrawal of the rejection of these claims is requested.

Claim 15

Claim 15 stands rejected under 35 USC §102(b) as anticipated by Hammond. The Office Action states:

> "Regarding claim 15, Hammond teaches (see Fig. 2) a method for reducing aberrations in a wavefront imaged by an optical system having a non-linear detector (30) (see Col. 8, lines 63-67), comprising: encoding (24) a wavefront of electromagnetic radiation from an object (10) imaged to the non-linear detector; digitally converting data from the non-linear detector to form a digital representation of the image captured by the detector (see Col. 4, lines 43-45); linearizing the detected image to form a linearized image (to provide a proper gray scale image – See. Col. 8, lines 54-56); and filtering (see Col.9, lines 1-7) the linearized image to reverse effects of wavefront coding to form a final image." Office Action, pages 3-4.

Claim 15 is for a method for reducing aberrations in a wavefront imaged by an optical system having a non-linear detector, and requires:

encoding a wavefront of electromagnetic radiation from an object imaged to the non-linear detector;

digitally converting data from the non-linear detector to form a digital representation of the image captured by the detector;

linearizing the detected image to form a linearized image; and

filtering the linearized image to reverse effects of wavefront coding to form a final image.

As argued above with respect to the rejection of claim 1, Hammond does not disclose either an "object imaged to the non-linear detector" or the step of "linearizing the detected image to form a linearized image," both of which are required elements of claim 15. As discussed in connection with claim 1, Hammond does not disclose the use of a non-linear detector, or "linearizing the detected image to form a linearized image". Furthermore, while the Office Action states that Hammond discloses "digitally converting data from the non-linear detector to form a digital representation of the image captured by the detector (see Col. 4, lines 43-45)", the passage from Hammond quoted by the Office Action does not appear to refer to a sensor or digital signal processing at all, and appears to be only a recitation of the language of claim 15. It is not immediately clear which passage, if any,

from Hammond that the Examiner intended to quote, and Applicants respectfully request clarification if the rejection of claim 15 is maintained.

As discussed above, Applicants believe that it is clear that Hammond does not disclose all of the required elements of claim 15, including at least "encoding a wavefront of electromagnetic radiation from an object imaged to the non-linear detector" and "linearizing the detected image to form a linearized image". For at least these reasons, Hammond does not anticipate claim 15 under 35 U.S.C. §102(b); reconsideration and withdrawal of the rejection of claim 15 is requested.

6 - 8. Claim Rejections – 35 USC §103(a)

Claim 4

Claim 4 stands rejected under 35 USC §103(a) as unpatentable over Hammond in view of U.S. Patent No. 3,988,608 ("O'Meara" herein). Claim 4 is for "The system of claim 1, wherein the non-linear detector comprises film." Claim 4 therefore benefits from like arguments for patentability as claim 1, discussed above.

The Office Action states that "O'Meara teaches a similar non-linear optical system with a non-linear detector comprising film (see Abstract and Col. 2, lines 13-16 and Col. 2, lines 51-54 and Col. 2, line 66 to Col. 3, line 1)." Office Action, page 4. But this statement is not true; O'Meara does not, in the cited passages or anywhere else, teach a non-linear detector comprising film, as will be shown. Furthermore, the Office Action states "It would have been obvious ... to provide the non-linear detector comprising film, as taught by O'Meara, in the device of Hammond, to provide incorporation of the device into existing optical systems and devices, as taught by O'Meara (see Col. 1, lines 51-54 and Col. 2, lines 14-17." This statement is a profound mis-characterization of the disclosure of O'Meara and its applicability to Hammond, as will also be shown.

O'Meara teaches a completely different system, operated under completely different principles, for completely different goals than the Office Action purports.

First, O'Meara does not teach a "similar non-linear optical system." O'Meara's system is an "Adaptive Imaging Telescope with Nonlinear Sensing and Electro-Optical Phase Shifting." O'Meara, title. But Hammond teaches an "Apparatus and Method for

Reducing Imaging Errors in Imaging Systems Having an Extended Depth of Field" (Hammond, title). O'Meara's system is fundamentally a telescope - which is recognized in the art as imaging objects that are at an infinite distance, so that "extended depth of field" is not an issue.

Second, O'Meara does not teach a "non-linear detector comprising film." O'Meara is concerned with "Image Quality," and implements an "Image Quality Sensor (Subsystem) 77" (shown in Fig. 4 and described at col. 6, line 54 - col. 7, line 2 of O'Meara) to detect and provide phase correction information (to compensate for atmospheric turbulence effects - see O'Meara col. 1, lines 13-50 and col. 2, lines 8-12). One embodiment of image quality sensor 77 is a nonlinear "photodetector plate 82" shown in Fig. 5a and discussed at col. 6, lines 45-51. But O'Meara's nonlinear photodetector plate 82 is not an imaging device, it is a single cell that provides a single output line designated as 97 that provides input to an analog perturbation correction system: "Accordingly, error signals may be provided from the detector unit as at 97 as output of the image quality sensor 77 to provide inputs to analog system 100." O'Meara, col. 6, lines 52-54.

In O'Meara's telescope, the actual imaging - which only might be on film - takes place at a completely different location than the non-linear sensor: "Optical beam as at 68 is propagated through the matrix elements of FIGS. 2 or 3 to impinge upon and be reflected from beam splitter 69 to be split as beam 70 impinging on lens 71, and exiting lens 71 as beam 72 to impinge as a normal image upon a photographic plate or the like [for example - film] as at 73." O'Meara, col. 6, lines 34-39. Fig. 2 shows the relative locations of 73 and image quality sensor 77, with image quality sensor 77 forming part of a feedback loop that uses analog system 100 to control a "Coat Control Phase Matrix 67" to improve quality in an optical beam 68 that is both imaged at 73 and provides input to image quality sensor 77.

Therefore, O'Meara does not say anything at all about a "non-linear detector comprising film." Even the numerous citations at page 4 the Office Action as quoted above do not include such teaching, as now shown. The Abstract reads, in full:

> "An adaptive imaging telescope having nonlinear sensing means for detecting an optical beam received thereby. The system comprises a phase shifter, positioned at the aperture of the telescope, responsive to the optical

> beam. This system also includes a nonlinear image quality sensor, optically coupled to the phase shifter, comprisinng a photodetector plate responsive to the optical beam for converting the optical beam into an electrical signal. Analog circuits are provided to receive the sensor output and provide a closed-loop return to the phase shifter." O'Meara, Abstract.

The Abstract therefore mentions a "nonlinear image quality sensor" (77, discussed above) that may include a "photodetector plate" (82, discussed above) - which is not used for imaging, but rather "for converting the optical beam into an [that is, a single] electrical signal."

Column 2, lines 13-16 read, in full:

> "A still further object is to provide a system fully compatible with post-film-recording restoration techniques, which then combined with the instant invention extend thereto an additional benefit." O'Meara, col. 2, lines 13-16.

This passage mentions "post-film-recording restoration techniques," but nothing about film itself.

Column 2, lines 51-54 read, in full:

> "On the other hand, if we use a 'nonlinear' detector wherein the local current or voltage increases at a higher rate than linear with local optical intensity, a quite different result is obtained." O'Meara, col. 2, lines 51-54.

Upon reading and appreciating this passage in context, that is, after reading col. 2, lines 20-50 and applying this information to the discussion of O'Meara's Fig. 4 and Fig. 5a at col. 5, line 66 through col. 7, line 2, it is clear that the "nonlinear" detector being discussed is photodetector plate 82, not film.

Column 2, line 63 to column 3, line 1 read, in full:

> "For two images which have substantial overlap (under high distortion or noncorrected conditions), the matter is not so obvious, although the essential conclusions remain true. Therefore, in this particular approach, it is proposed to examine the integral of the square (or other nonlinear functional form) of the image intensity distribution as a function of the various aperture phase controls." O'Meara, col. 2, line 63 to col. 3, line 1.

This passage is part of a discussion of how the nonlinear detector (but again, not film) can be utilized to gauge or form a correction signal to improve image sharpness, as is

appreciated by reading through from the col. 2, lines 51-54 citation above through to col. 2, line 66.

Therefore, O'Meara does not teach a "similar non-linear optical system" and does not teach a "non-linear detector comprising film." And, O'Meara and Hammond teach wholly dissimilar systems. It follows that there is no motivation to combine the teachings of O'Meara with those of Hammond to obtain the requirement of claim 4, and if even there were such motivation, that the requirement of claim 4 would still not be present in an indiscriminate combination of O'Meara and Hammond. The Office Action's purported motivation for such combination: "...to provide incorporation of the device into existing optical systems and devices, as taught by O'Meara (see Col. 1, lines 51-54 and Col. 2, lines 14-17" is meaningless, as both of the cited passages merely note the existence of and desirable compatibility with "post-film-recording or restoration system" (in col. 1) and "post-film-recording restoration techniques (in col. 2) - which do not require that film is even used, and do not speak in any way to what it is that would be desirable to incorporate in Hammond from O'Meara or vice versa.

Since claim 4 depends from claim 1, argued above as patentable, and since there is no motivation to combine the teachings of O'Meara with those of Hammond, and the limitations of claim 4 would not be present in such combination in any case, claim 4 is not unpatentable under 35 U.S.C. §103(a) over Hammond in view of O'Meara. Reconsideration and withdrawal of the rejection of claim 4 is requested.

Claim 6

Claim 6 stands rejected under 35 USC §103(a) as unpatentable over Hammond in view of U.S. Patent No. 5,367,375 ("Siebert" herein). Claim 6 is for "The system of claim 1, wherein the optics comprise an optical element with an aspheric phase profile." Claim 6 therefore benefits from like arguments for patentability as claim 1, discussed above.

The Office Action states that "Siebert teaches a similar device with optics comprising an optical element with an aspheric phase profile (see Col. 10, lines 53-55.) ... [and] It would have been obvious ... to provide the optics comprising an optical element with an aspheric phase profile, as taught by Siebert, in the device of Hammond, to provide

wavefront coding patterns that are optimized to correct focusing aberrations for a clearer image." Office Action, page 5.

Neither of these statements in the Office Action is true.

First, Siebert does not "teach[] a similar device with optics comprising an optical element with an aspheric phase profile." Siebert teaches "Spatial Wavefront Evaluation by Intensity Relationship." Siebert, title. Siebert assigns the acronym "SWEBIR" to this technique (see Siebert, col. 2, lines 53-55 and col. 4, lines 11-13). The passage cited in the Office Action reads, "SWEBIR may also be employed to measure the curvature of aspherics without a null lens." Therefore Siebert does not teach "a similar device with optics comprising an optical element with an aspheric phase profile" but rather a technique that can "measure the curvature of aspherics." That is, aspheric surfaces are, to Siebert, a workpiece for a measurement system, not the measurement system itself. Therefore the limitations of claim 6 cannot be found in Hammond in view of Siebert, even in indiscriminate combination.

Second, there is nothing in Siebert or known to those skilled in the arts to suggest that providing "wavefront coding patterns that are optimized" would result from the incorporation of anything taught in Siebert into Hammond's system.

Since claim 6 depends from claim 1, argued above as patentable, and since there is no motivation to combine the teachings of Siebert with those of Hammond, and since the limitations of claim 6 would not be present in such combination in any case, claim 4 is not unpatentable under 35 U.S.C. §103(a) over Hammond in view of Siebert. Reconsideration and withdrawal of the rejection of claim 6 is requested.

9 - 11 Allowable Subject Matter

Applicants acknowledge the Office Action's indication that claim 23 is allowed over the art of record, and that claims 5, 7, 9, 10, 12-14 and 16-22 would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. New claims 24-30 depend from claim 23 and are believed patentable over the art of record because of the indicated patentability of claim 23. New claim 31 includes the limitations of claim 5 and its base claim 1, and is believed patentable over the art of record

because of the indicated patentability of claim 5 if rewritten to include base claim limitations. New claims 32-37 depend directly or indirectly from claim 31 and benefit from like reasons for patentability.

Conclusion

In view of the above Amendments and Remarks, Applicant has addressed all issues raised in the Office Action dated 21 March 2008, and respectfully solicits a Notice of Allowance. Should any issues remain, the Examiner is encouraged to telephone the undersigned.

The fee of $460 for a two-month extension of time is enclosed herewith. Applicant believes no OTHER fees are currently due, however, if any fee is deemed necessary in connection with this Amendment and Response, please charge Deposit Account No. 12–0600.

Respectfully submitted,

LATHROP & GAGE L.C.

Date: 21 Aug 2008

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